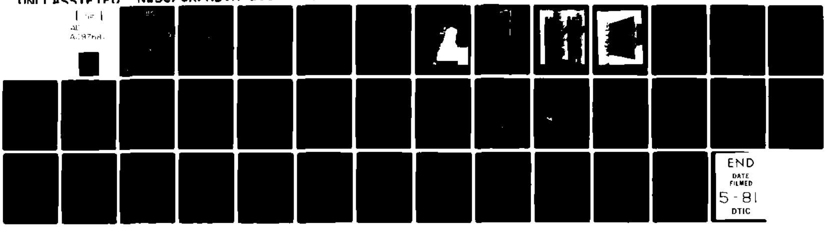
AD-A097 681 NAVAL WEAPONS SUPPORT CENTER CRANE IN F/G 11/9
DEVELOPMENT AND EVALUATION OF A MODIFIED POLYSTYRENE FOAM SPACE--ETC(U)
SEP 80 F A NIEHAUS, R A SHAW
UNCLASSIFIED NWSC/CR/RDTR-133 NL



LEVEL II

(14)

AD A097681

UNCLASSIFIED NWSC/CR/RDTR-133

DEVELOPMENT AND EVALUATION OF A MODIFIED POLYSTYRENE FOAM SPACER FOR USE WITH THE SONOBUOY LAUNCH CONTAINER ABOARD S-3A and P-3C AIRCRAFT

30 September 1980

By

FRANK A. NIEHAUS
and
REID A. SHAW

PREPARED BY

APPLIED SCIENCES DEPARTMENT

NAVAL WEAPONS SUPPORT CENTER, CRANE, INDIANA

81 3 2 045

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

14

1. REPORT NUMBER: NWSC/CR/RDTR-133

2. GOVT ACCESSION NO.: AD-A097681

3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle):

6

DEVELOPMENT AND EVALUATION OF A MODIFIED POLYSTYRENE FOAM SPACER FOR USE WITH THE SONOBUOY LAUNCH CONTAINER ABOARD S-3A AND P-3C AIRCRAFT

5. TYPE OF REPORT & PERIOD COVERED:

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s):

10

Frank A. Niehaus, Design Engineer
Reid A. Shaw, Evaluation Engineer

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS:

Commanding Officer
Naval Weapons Support Center (Code 5045)
Crane, Indiana 47522

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:

11. CONTROLLING OFFICE NAME AND ADDRESS:

12 39

11

12. REPORT DATE: 30 Sep[redacted]80

13. NUMBER OF PAGES: 35

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office):

15. SECURITY CLASS. (of this report): Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report):

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report):

18. SUPPLEMENTARY NOTES:

19. KEY WORDS (Continue on reverse side if necessary and identify by block number):

Mk 25 Marine Location Marker, Mk 84 Underwater Sound Signal, S-3A Aircraft, P-3C Aircraft, Sonobouy Launch Container, Packaging, Polystyrene Foam

20. ABSTRACT (Continue on reverse side if necessary and identify by block number):

This report discusses the malfunction investigation and redesign of a spacer assembly for launching Mk 25 Marine Location Markers and Mk 84 Underwater Sound Signals from sonobuoy launch containers aboard S-3A and P-3C aircraft. The spacer which is molded from polystyrene foam is packaged four to a polystyrene foam container and unitized 20 containers (80 Spacer Assemblies) to a 40 x 48 pallet.

409351

ACKNOWLEDGEMENT

The authors wish to acknowledge the assistance of Mr. Steve Hardy in the design of the spacer, Mr. Steve Schantz in the evaluation of the spacer, and Mr. James Richardson in finding a solution to in-service problems. The authors also wish to acknowledge the assistance of personnel from Code 306, Weapons Quality Engineering Center, Naval Weapons Support Center, Crane, LCDR Bianco and Mr. L. Crain of COMNAVAIRPAC and AOC Autrey Air Antisubmarine Squadron 41 (VS41) in evaluation of the spacer.

TABLE OF CONTENTS

LIST OF TABLES

I. BACKGROUND

Initial Development. During 1972 the Naval Air Development Center (NAVAIRDEVCEN) at Warminster, PA, was tasked to provide S-3A aircraft with a capability of launching Mk 25 Marine Location Markers or Mk 84 Underwater Sound Signals. Because the S-3A lacked any launching equipment specifically designed for 3" diameter size stores, the 5" diameter sonobuoy launch container was adapted to accommodate the smaller size stores. NAVAIRDEVCEN's design consisted of a polystyrene foam spacer that was adaptable to both stores and supported the stores over their entire length. The design was also compatible with the Mk 34 Marine Marker Adaptor Kit which provides a water-tight seal for the battery cavity of the marine marker while the pyrotechnic device is in the launcher.

Malfunction Reports. This spacer presented the same outline form and size as an "A" size sonobuoy which it replaced in the sonobuoy launch container. The two symmetrical halves were parted along the longitudinal centerline for ease in packaging and reliable separation from the stores after ejection. Although this design was used successfully during development tests reported in NAVAIRDEVCEN Report No. NADC-77244 VT dated 13 January 1973 and several years thereafter, numerous malfunction reports were made during 1978 and 1979 following a change made to the shear pins used on the KMU-410/B sonobuoy retainer kit end cap. The shear pins (Figure 1) on this end cap hold the spacer assembly in the launch container prior to ejection by a Cartridge Actuated (CAD) gas generator. The strengthening of the shear pins was necessary to prevent premature or inadvertent ejection of the much heavier sonobuoy during arrested landings or take-offs from carriers. Although the increased strength kept the sonobuoy in place, it also meant that more force was necessary to eject the spacer assembly with its store.

The stronger shear pins, along with the fact that the spacer assembly was 3/16" to 1/4" shorter (Figure 2) than required by NAVAIRDEVCEN's original drawing, seem to be the main cause for the malfunction. The malfunction reports indicated that the foam spacer was collapsing (Figure 3), allowing the obturator between it and the CAD to become tilted, and the gas pressure to vent thereby preventing the shear pins from being sheared. In some instances, as many as four spacer assemblies were not ejected during a single flight (see Figure 4).

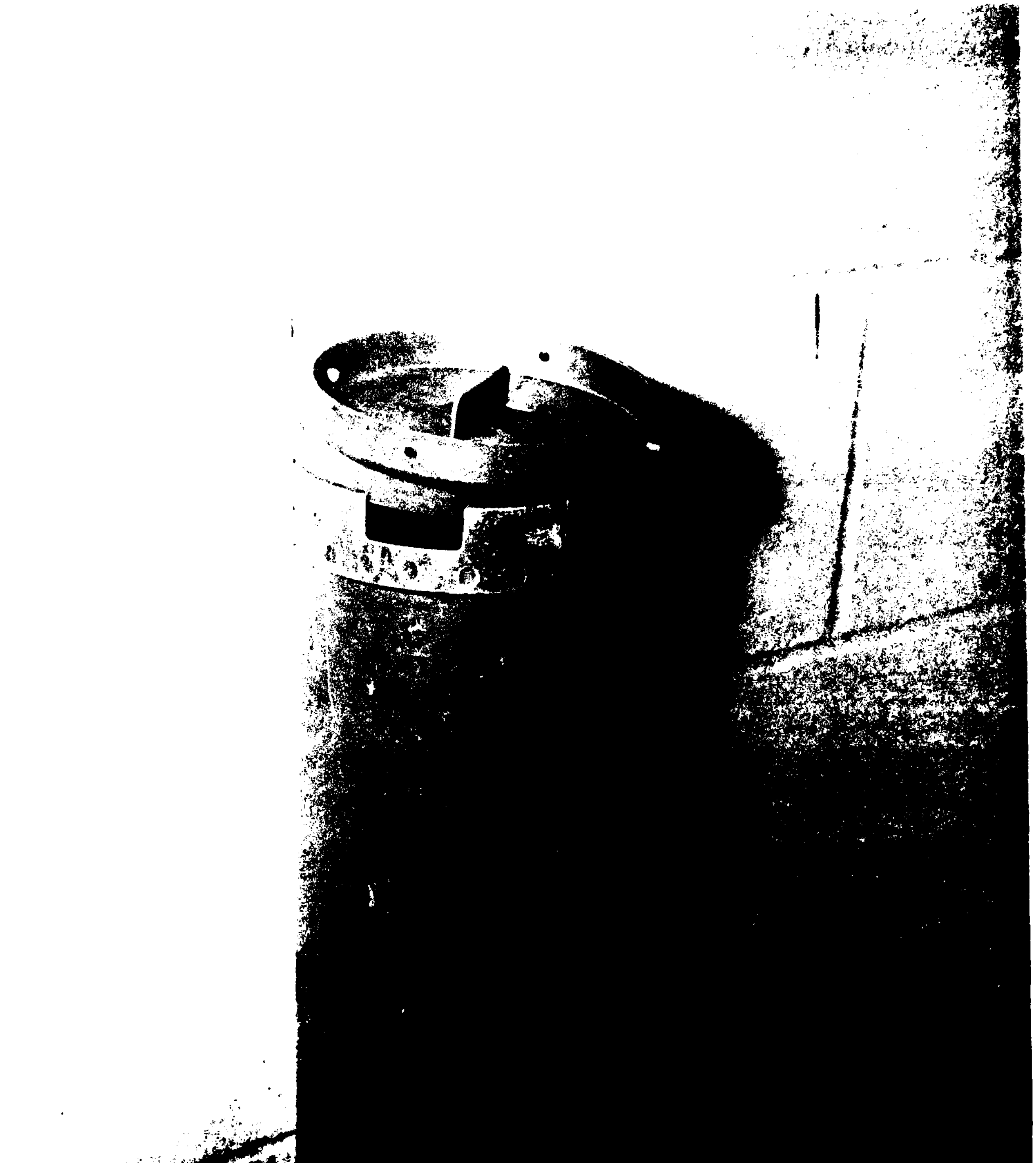


FIGURE 1

Sonobuoy Launch Container with KMU-410B
Retainer Kit End Cap

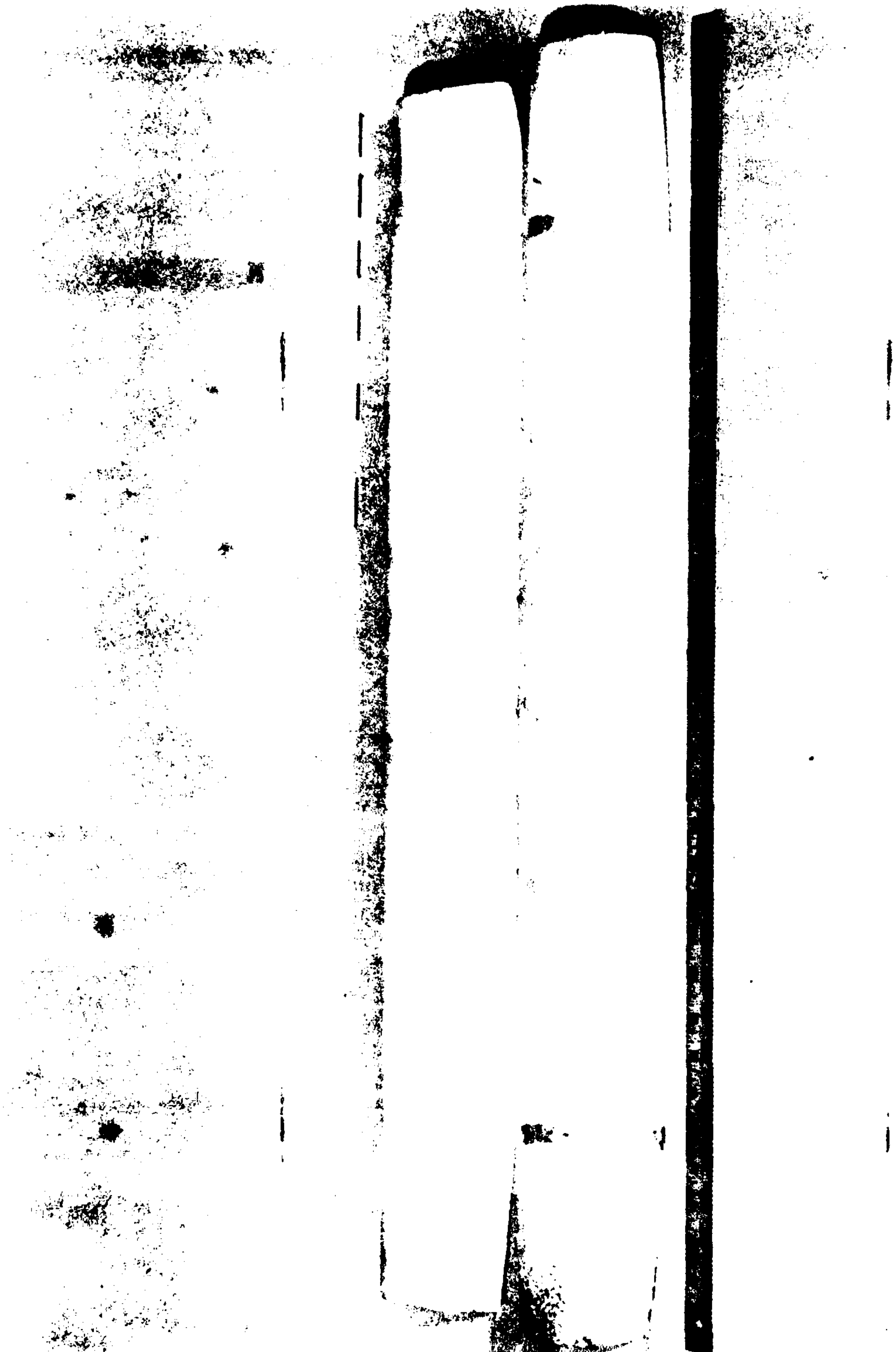
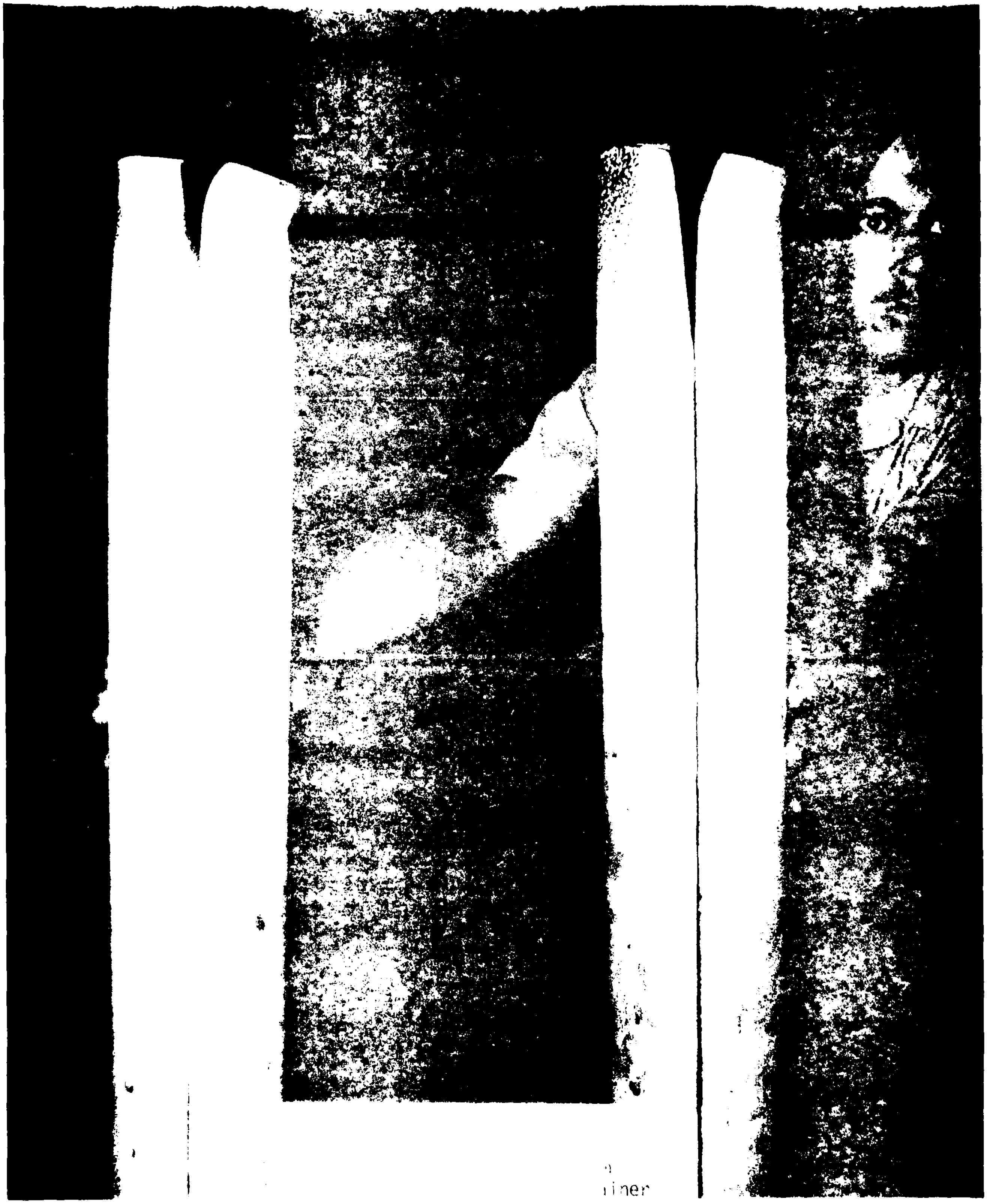
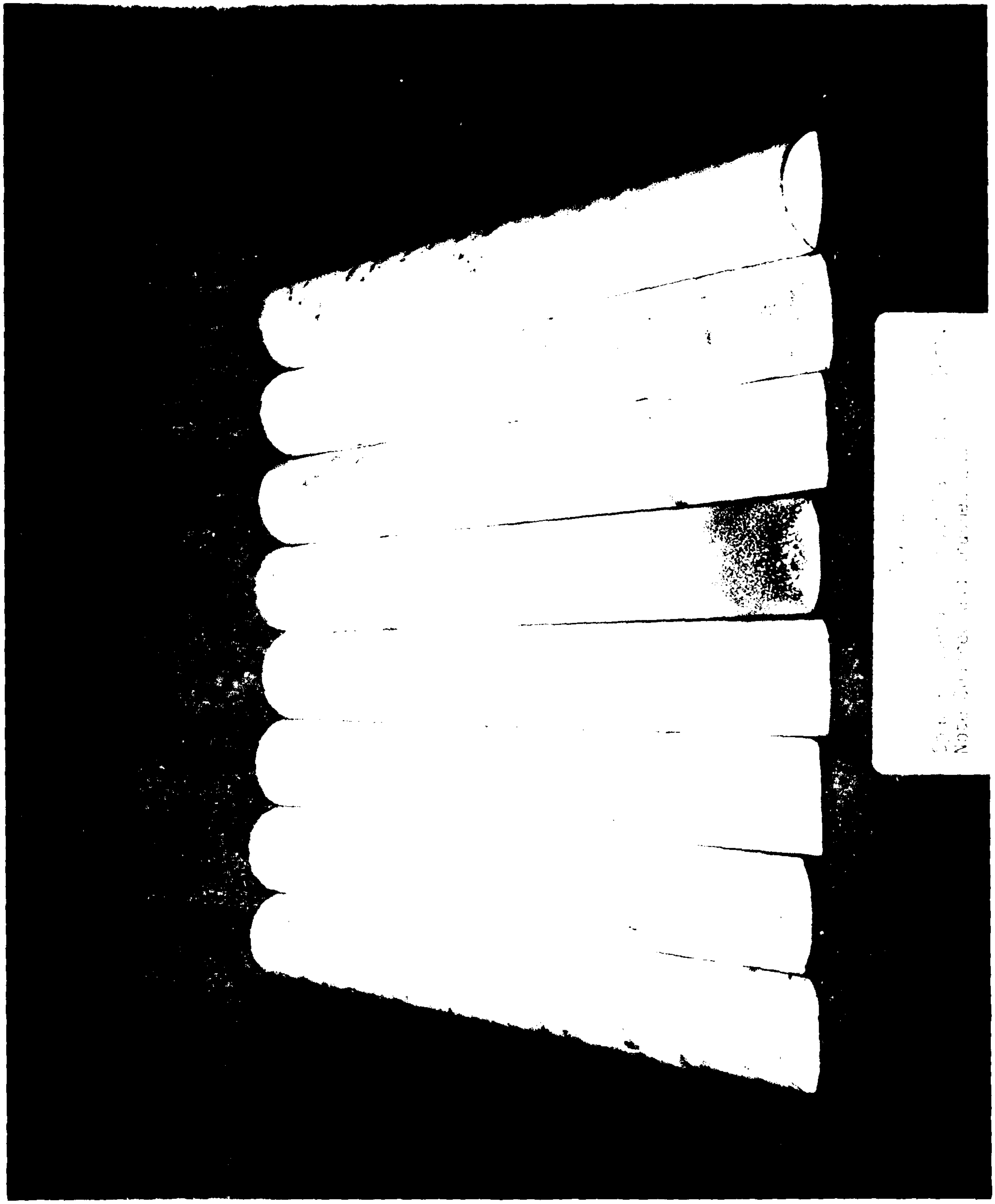


FIGURE 2

Old Spacer Assembly



iner



Shipboard Handling and Storage Problems. Along with the malfunction reports, there were also reports of problems in handling and storage of these spacer assemblies aboard carriers. Although the spacers were made out of a self-extinguishing grade of polystyrene foam, they were normally packaged in large fiberboard boxes for shipment from the manufacturer. These boxes were not designed nor were they suited for a shipboard environment. The spacers that were stored aboard carriers were usually handled individually and stored like cordwood.

Naval Air Systems Command, therefore, requested that Code 505, Naval Weapons Support Center (NAVWPNSUPPCEN), Crane, design and develop a system for handling and storing the spacer assemblies aboard carriers.

II. MALFUNCTION INVESTIGATION

In an effort to establish why and/or how the spacer assemblies were failing, ten static ejection tests were performed by Code 5045 and the Weapons Quality Evaluation Center, NAVWPNSUPPCEN Crane. Three out of the first five spacer assemblies were loaded with an inert Mk 25 Mod 3 Marine Location Marker equipped with the Mk 34 Adaptor Kit. The other two were loaded without the Mk 34 Adaptor. All five spacer/marker assemblies ejected satisfactorily as indicated in Table I.

Further assessment of the problem revealed that the S-3A loading manual did not require the Mk 34 Adpator Kit and it had not been used by the Fleet. Use of this adaptor was intended as a safety feature and was included in developmental testing by NAVAIRDEVCEN Warminster. If the adaptor kit is not used approximately 1/4 to 3/8 inch of the length of the marker cavity inside the spacer assembly is void. This condition allows the symmetrical halves to slide or shift with respect to one another inside the launch container.

When this happens, the obturator is partially unsupported and can tilt upon CAD functioning. The tilted obturator allows pressure loss or blowby and prevents ejection of the spacer/marker assembly. It was initially believed that this condition could be corrected by the use of the Mk 34 Adaptor Kit.

TABLE I

Spacer: P/N MM19887 FMC-13479 9-76
Contract N00383-76-C-3486
NSN 5845-00-140-8514
CAD: Lot No. 17-REX-0877
KMU-410/B Kit: 3003-1019AS100 FSCM 95244
Contract N00383-78-C-2409
NSN 5845-01-040-5583
Marker: Mk 25 Mod 3 Inert Marine Location Marker

Test No.	Length Inches	Diameter Inches	Force Lbs	Avg Velocity Ft/Sec	Mk 34 Adaptor Used	End of Marker Towards Breech	Remarks
1	35.75	4.728	1140	68.18	Yes	Nose	Satisfactory
2	35.69	4.746	800	61.22	Yes	Nose	Satisfactory
3	35.69	4.748	1840	62.50	Yes	Base	Satisfactory
4	35.69	4.730	1360	68.18	No	Nose	Satisfactory
5	35.69	4.737	1800	65.22	No	Base	Satisfactory

In an effort to duplicate the malfunction, the last five static ejection tests (Table II) were conducted without the Mk 34 Adaptors and with the spacer halves offset. Ejection failures were not reproduced as all units ejected satisfactorily. Even though launcher failures were not reproduced in the static ejections, it was still suspected that the absence of the adaptor contributed to the reported malfunctions. Further, the adaptor is needed to minimize the probability of ignition of the markers should the S-3A Aircraft have to make an emergency landing in salt water.

An on-site investigation was also conducted at the Naval Air Antisubmarine Squadron Four One in San Diego on 14-15 August 1979 in an effort to duplicate launch failures. Seventeen Mk 25 Markers equipped with adaptors and 17 markers without adaptors were loaded into foam spacers and placed in sonobuoy launch containers aboard the S-3A Aircraft. All markers were successfully ejected (Table III). Since the malfunction could not be duplicated, additional efforts were made to determine what caused the failure.

Short foam spacers and failure to use the flexible foam discs of the KMU 410/B Sonobuoy Launch Container Kit would cause an increase in the amount of free longitudinal space inside the launch container. This increased space was also suspected as a possible failure mode, but five additional tests using spacers that were shortened in length as much as 1.375 inches failed to duplicate the malfunction since all five spacer/marker assemblies were successfully ejected, Table IV.

A total of forty-nine ejections were made during the malfunction investigation, but the reported problem was never duplicated and since the malfunction wasn't duplicated, no definite assessment of the cause of the malfunction could be made. Further testing was also considered unwarranted since the original spacer has been redesigned and the new design has been tested and released to the Fleet.

Because of a critical need for the spacer, COMNAVAIRPAC recommended that an emergency procurement of the original spacer be made to alleviate projected degradation of ASW operations until new spacers were available. However, the last manufacturer of the original spacer had destroyed the molds and the possibility of immediate procurement was

TABLE II

Spacer: P/N MM19887 FMC-13479 9-76
Contract N00383-76-C-3486
NSN 5845-00-140-8514
CAD: Lot No. 17-REX-0877
KMU-410/B Kit: 3003-1019AS100 FSCM 95244
Contract N00383-78-C-2409
NSN 5845-01-040-5583
Marker: Mk 25 Mod 3 Inert Marine Location Marker
without Mk 34 Adaptor Kit

Test No.	Spacer Orientation with Respect to Shear Pins	Spacer Halves Taped and Shifted	End of Marker Towards Breech	Force Lbs	Avg Velocity Ft/Sec
6	90^{o}	Yes	Base	2100	61.0
7	90^{o}	Yes	Base	2300	66.7
8	In Line	Yes	Base	2300	60.0
9*	In Line	No	Base	2600	56.6
10	In Line	No	Base	2500	65.2

*Obturator reversed during test number nine, but no ejection failures occurred during this test or any of other five tests.

TABLE III

Spacer: P/N MM19887 FMC-13479 9-76
Contract N00383-76-C-3486
NSN 5845-00-140-8514
CAD: Lot JAU-1/B 10-REX-0578
KMU-410/B Kit: 3003-1019AS100 FSCM 95244
Contract N00383-78-C-2409
NSN 5845-01-040-5583
Marker: Mk 25 Marine Location Markers
Lots 8KC-0374 and 18-KC-0469

Test No.	Mk 34 Adaptor Kit	Satisfactory Ejection
1	No	Yes
2	Yes	Yes
3	No	Yes
4	Yes	Yes
5	No	Yes
6	Yes	Yes
7	No	Yes
8	Yes	Yes
9	No	Yes
10	Yes	Yes
11	No	Yes
12	Yes	Yes
13	No	Yes
14	Yes	Yes
15	No	Yes
16	Yes	Yes
17	No	Yes
18	Yes	Yes
19	No	Yes
20	Yes	Yes
21	No	Yes
22	Yes	Yes
23	No	Yes
24	Yes	Yes
25	No	Yes
26	Yes	Yes
27	No	Yes
28	Yes	Yes
29	No	Yes
30	Yes	Yes
31	No	Yes
32	Yes	Yes
33	No	Yes
34	Yes	Yes

TABLE IV

Spacer: P/N MM19887 FMC-13479 9-76
Contract N00383-76-C-3486
NSN 5845-00-140-8514
CAD: Lot No. 17-REX-0877
KMU-410/B Kit: 3003-1019AS100 FSCM 95244
Contract N00383-78-C-2409
NSN 5845-01-040-5583

Test No.	Length Inches	Force Lbs	Avg Velocity Ft/Sec	Type Store	End Towards Breech	Obturator
1	34 3/4	840	--	Mk 25	Nose	Normal
2	34 5/8	800	34.8	Mk 25	Nose	Normal
3	35 1/4	800	35.7	Mk 25	Nose	Normal
4*	34 5/8	400	30.0	Mk 25	Nose	Tilted
5	34 3/4	1200	31.2	Mk 84	Nose	Tilted

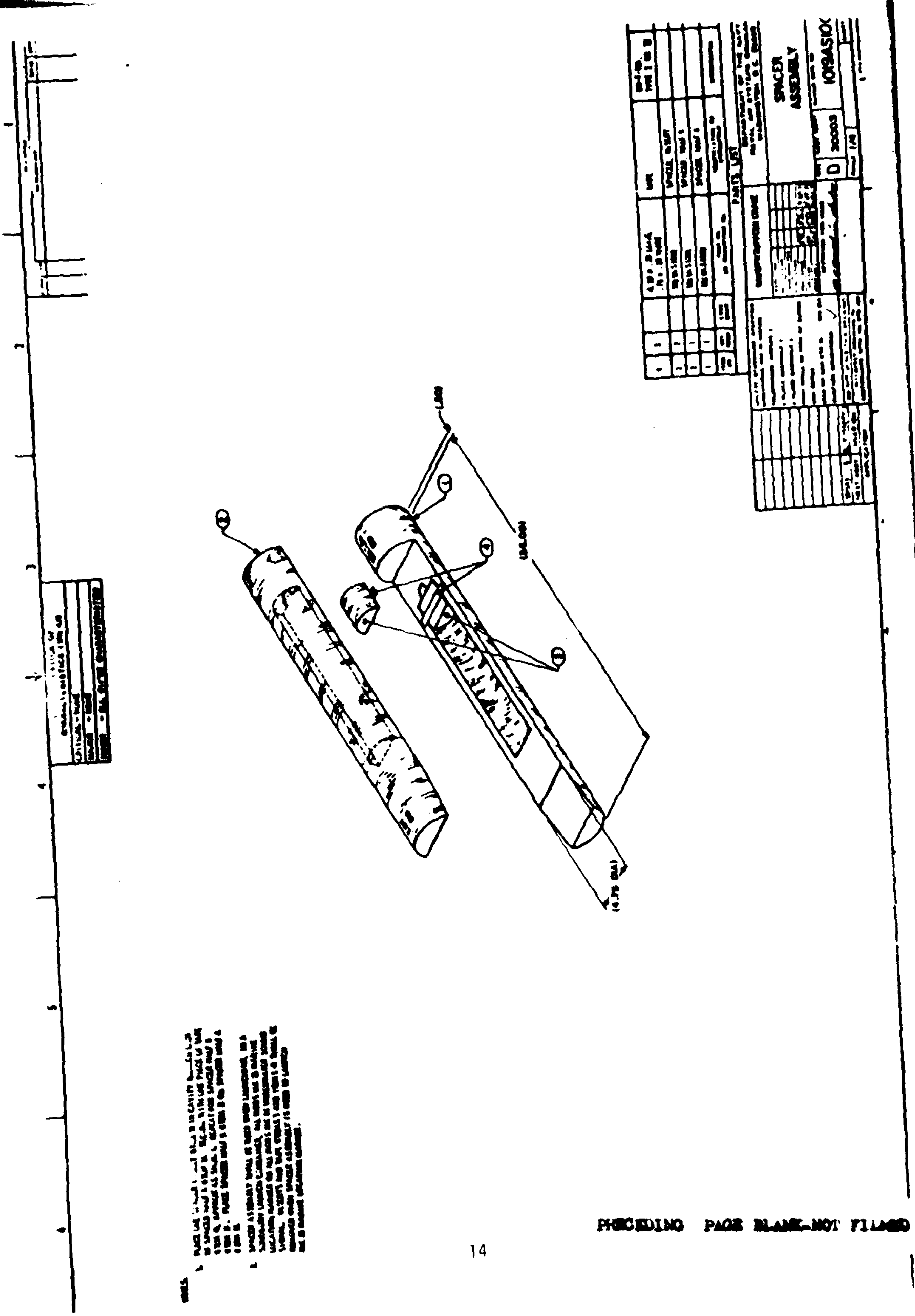
*Spacer broke after ejection.

ruled out. Priority procurement of the original spacer was also ruled out since it would save only the 30 days that were required for first article tests on the new spacer. The most practical approach to meet the needs of the Fleet was concluded to be the procurement of new spacers that were modified to preclude their malfunction.

New Spacer Design. After the malfunction investigation reports, as well as the suggested changes by Fleet personnel and Mr. Howard Grounds of Naval Avionics Center, Indianapolis, were reviewed, it was concluded that the ideal spacer should consist of two parts with the portion near the obturator having a cylindrical cross section and a hemispherical shape on the end (Figure 5). This cylindrical cross section would act as a solid plug which could not tilt inside the launch container. The hemispherical shape of the breech end fit the internal contour of the obturator and further prevented tilting. The remaining portion of the spacer was identical to the original spacer designed by NAVAIRDEVCEN Warminster. Since the spacer was designed to have a particular orientation in the launch container vice being reversible as it was originally designed, it was also necessary to mold the words "breech end" and "exit end" on the appropriate ends of the spacer. The auxiliary spacer used with the Mk 84 Underwater Sound Signal with the original design was also utilized with the new design.

Container Design. Packaging and container development at NAVWPNSUPPCEN Crane, is centered around the application of plastics and lightweight foams to solve shipping needs or problems. The ideal packaging material for the spacers was considered to be polystyrene foam. With a minimum of 88 psi compressive strength, the spacers were also found to be capable of supporting considerably more than the proposed stacking of like containers to an overall height of 16 feet. In fact, each spacer is capable of withstanding end loading in excess of 1100 pounds before failure will occur.

Approximately 250 to 500 spacers will need to be stored aboard each carrier equipped with S-3A Aircraft; therefore, cube as well as compatibility with handling gear had to be considered. The weight of the spacer is less than two pounds, but it will occupy more than .4 of a cubic foot; therefore, for ease in handling and storage it should be



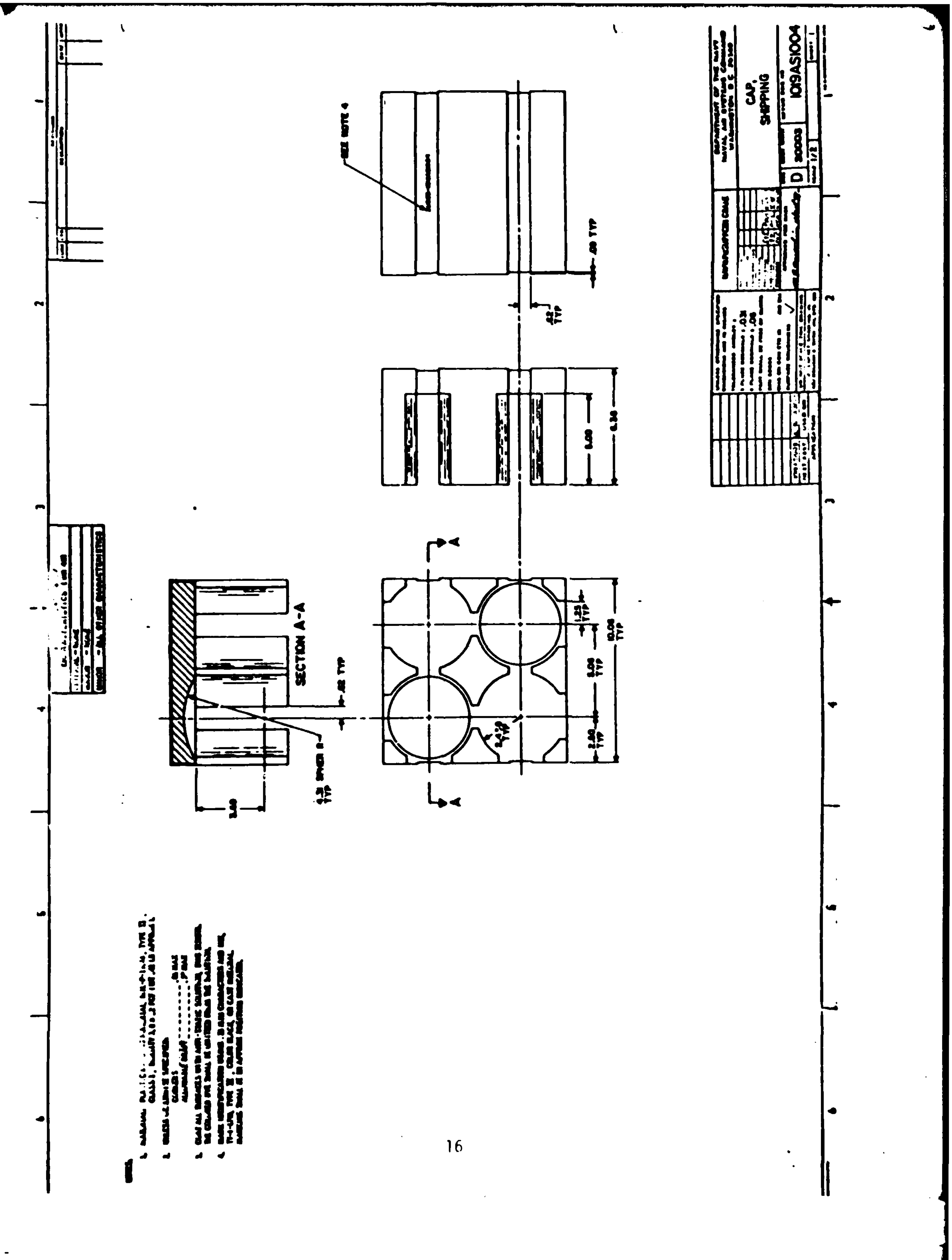
PRECEDING PAGE BLANK-NOT FILMED

palletized. Considering the fact that the spacer will take considerable end loading and is fairly rugged in itself, end caps were considered as the best means to consolidate the spacers. Since the diameter of the spacer was just under five inches, the number per package was selected so it could be palletized on a 40 x 48 inch metal pallet with no underhang and as little overhang as possible. Although several combinations were available, an end cap was selected for four spacer assemblies as depicted on Dwg 1019AS1004 (Figure 6). Two of these end caps would contain four spacers when secured with tape as shown on Dwg 1019AS1005 (Figure 7).

Twenty of these 10.06" x 10.06" four packs will fit on a 40" x 48" metal pallet in a 4 x 5 pattern with a total of 2-3/4 inches overhang in the 48-inch direction and only 3/4-inch overhang in the 40-inch direction. Palletization of the spacers is depicted on MIL-STD-1323/219. (Figures 8 and 9)

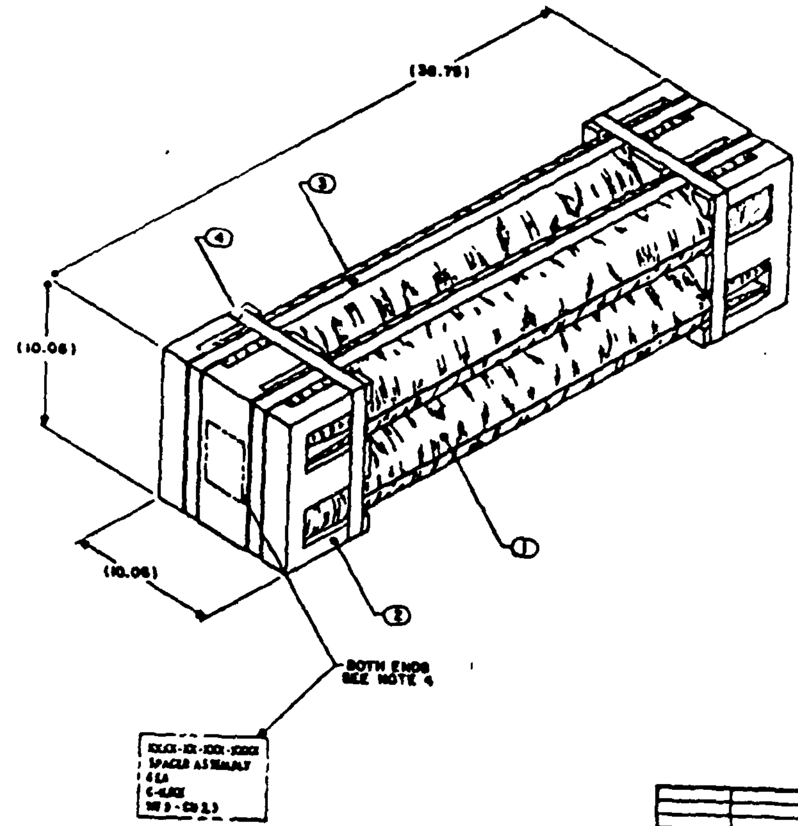
Spacer Evaluation. The modified spacer assembly (Figure 10) which is made entirely of polystyrene foam is 36.5 inches long, 4.75 inches in diameter and weighs approximately 1.73 pounds. It consists of two nonsymmetrical split sections with a cavity inside to accept a Mk 25 Marine Location Marker equipped with a Mk 34 Adaptor or a Mk 84 Underwater Sound Signal. A spacer insert 2.88 inches in length and 3.00 inches in diameter is provided and is to be utilized to fill part of the cavity when the Mk 84 Underwater Sound Signal is launched. The loaded spacer assembly is inserted into the sonobuoy launch container utilizing a KMU-410/B Sonobuoy Retainer Kit. The loaded sonobuoy launch container is then loaded into the sonobuoy launcher. The purpose of the spacer assembly is to provide a means of launching Mk 25 Marine Location Markers and Mk 84 Underwater Sound Signals from sonobuoy launchers aboard S-3A and P-3C Aircraft.

Since there was an immediate need for these spacers in the Fleet, the initial prototypes, heretofore classified as the first articles, were tied to a production order for 10,000 spacer assemblies. Contract N00104-80-C-A024 was awarded to Preferred Plastics, Putnam, Connecticut, on 14 January 1980 for the initial 250 spacers, as well as for the 10,000 production units. The first article sample of 250 was subsequently divided amongst NAVWPNSUPPCEN Crane who received 150 and NAVAIRTESTCEN Patuxent River, MD, who received 100 for flight tests and verification tests.


SECTION A-A
SEE NOTE 4
CAP, SHIPPING

NOTES:

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]



REFERENCES:

1. [illegible]
2. [illegible]
3. WEIGHT ______ [illegible] (CALC)
4. CUBAGE ______ [illegible] (CALC)

PARTS LIST

DEPARTMENT OF THE NAVY
NAVAL AIR SYSTEMS COMMAND
WASHINGTON, D.C.

PACK, SHIPPING AND STOR
(FOR 4 SPACER ASSEMBL

D 30003 1019AS1005

SCALE 1/4

MILITARY STANDARD

MIL-STD-1323-219
(NAVY)

23 SEPTEMBER 1980

UNIT LOAD
FOR UNDERWAY REPLENISHMENT

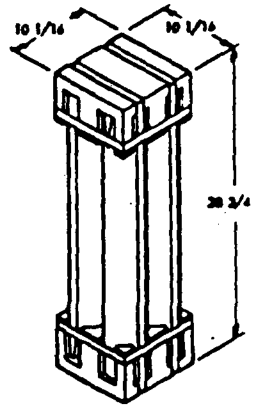
SPACER ASSEMBLY
FOR MARINE LOCATION MARKER MK 25 & MODS
OR UNDERWATER SOUND SIGNAL MK 84 & MODS

UNIT LOAD DATA DODIC / NALC 8W27

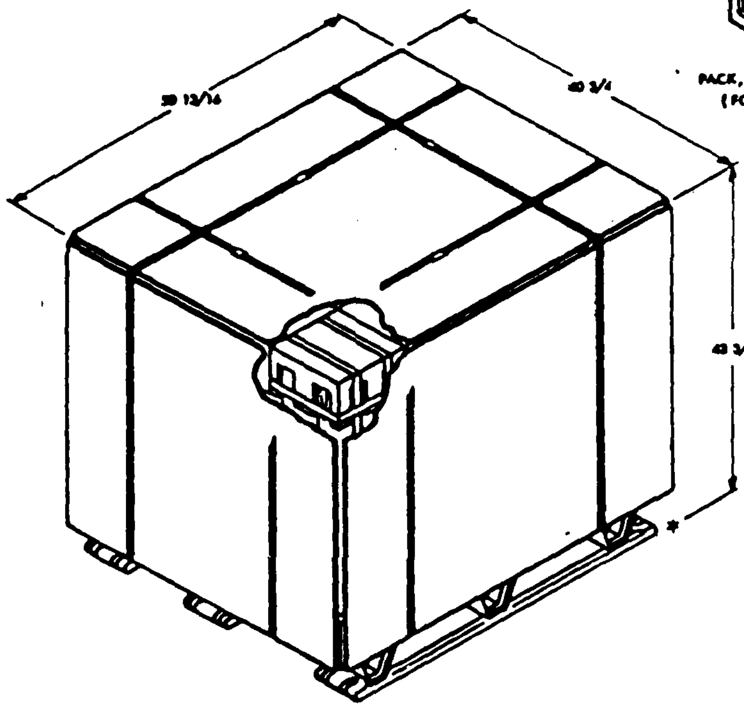
NUMBER OF FILLER ASSEMBLIES PER PACK	4
NUMBER OF PACKS PER UNIT LOAD	20
WEIGHT OF PACK (APPROX)	8 LBS.
WEIGHT OF WOOD (APPROX)	41 LBS.
WEIGHT OF STEEL STRAPPING (APPROX)	6 LBS.
WEIGHT OF PALLET (APPROX)	94 LBS.
WEIGHT OF UNIT LOAD (APPROX)	301 LBS.
CUBE	32.4 CU. FT.

DO NOT STACK MORE THAN
4 UNIT LOADS HIGH IN STORAGE

HAZARD CLASSIFICATION
NONE - INERT



PACK, SHIPPING AND STORAGE
(FOR 4 SPACER ASSEMBLY)
DL 1019AS1005



NOTES

1. UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
2. FOR CROSS REFERENCE TO ASSOCIATED TRUCKLOADING, CONTAINERLOADING AND CARLOADING MILITARY STANDARDS, REFER TO INDEX TO STANDARDS, MIL-HDBK-326 (NAVY).

FSC 8140

THIS UNIT LOAD IS AUTHORIZED AND RELEASED FOR SHIPPING, HANDLING, STORAGE AND TRANSFER-AT-SEA. IT MAY ALSO BE USED FOR DOMESTIC SHIPMENT IN COMPLIANCE WITH DOT REGULATIONS.

SIGNATURE TECHNICAL DIRECTION AGENT (TDA) DATE

SIGNATURE APPROVED BY DIRECTION DATE

REQUIREMENTS FOR CONSTRUCTION OF THIS UNIT LOAD SHALL CONSIST OF THIS DOCUMENT AND THE LATEST ISSUE OF MIL-STD-1323

ORIGINATOR DATE

NAVAL WEAPONS HANDLING CENTER
WPNSTA EARLE, NEW JERSEY

PAGE 1 OF 2

PALLETIZING PROCEDURE

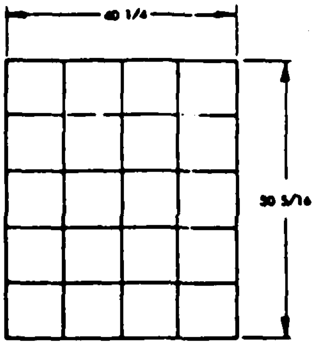
(a) THREAD STRAPPING, ITEM 2, BETWEEN DECK WIRES OF PALLET, ITEM 1, AS SHOWN IN DETAIL A.
(b) POSITION SPACER ASSEMBLY PACKS ON PALLET AS SHOWN IN PLAN VIEW OF PACK PATTERN.
(c) PLACE TOP PANEL, ITEM 5, ON UNIT LOAD
(d) WITH END PANELS, ITEM 4, IN PLACE, POSITION STRAPPING, ITEM 2, OVER END PANELS AND AROUND UNIT LOAD. TENSION AND DOUBLE NOTCH SEAL, ITEM 7.

NOTE

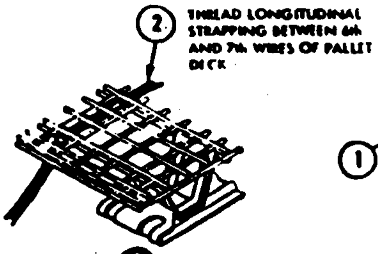
CENTER BOTH END AND SIDE PANELS BEFORE TENSIONING STRAPPING.

(e) POSITION STRAPPING, ITEM 6, UNDER PALLET DECK, OVER SIDE PANELS, ITEM 3, AND AROUND UNIT LOAD. TENSION AND DOUBLE NOTCH SEAL.

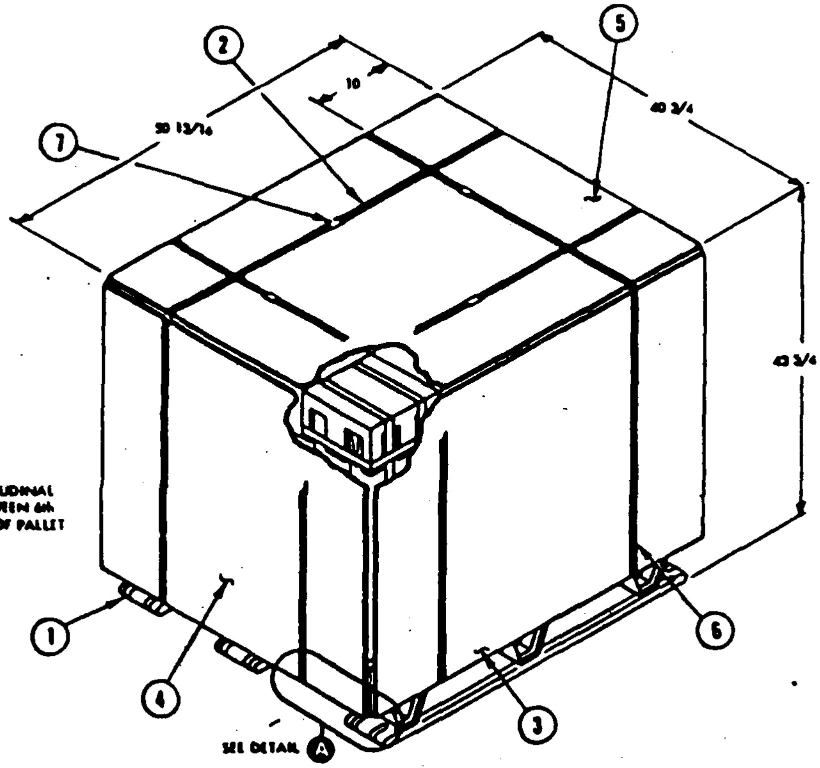
MARKING. THE UNIT LOAD SHALL BE MARKED IN ACCORDANCE WITH MIL-STD-1323.



PLAN VIEW OF PACK PATTERN (1 HIGH)



DETAIL A



NOTES

1. ALL MATERIALS SHALL BE AS SPECIFIED IN THE GENERAL DOCUMENT, MIL-STD-1323.
2. COLD ROLLED, HEAT TREATED .031 STRAPPING MAY BE SUBSTITUTED.

DEPALLETIZING PROCEDURE

(a) CUT AND REMOVE STRAPPING.
(b) REMOVE PROTECTIVE PANELS.
(c) REMOVE SPACER ASSEMBLIES.

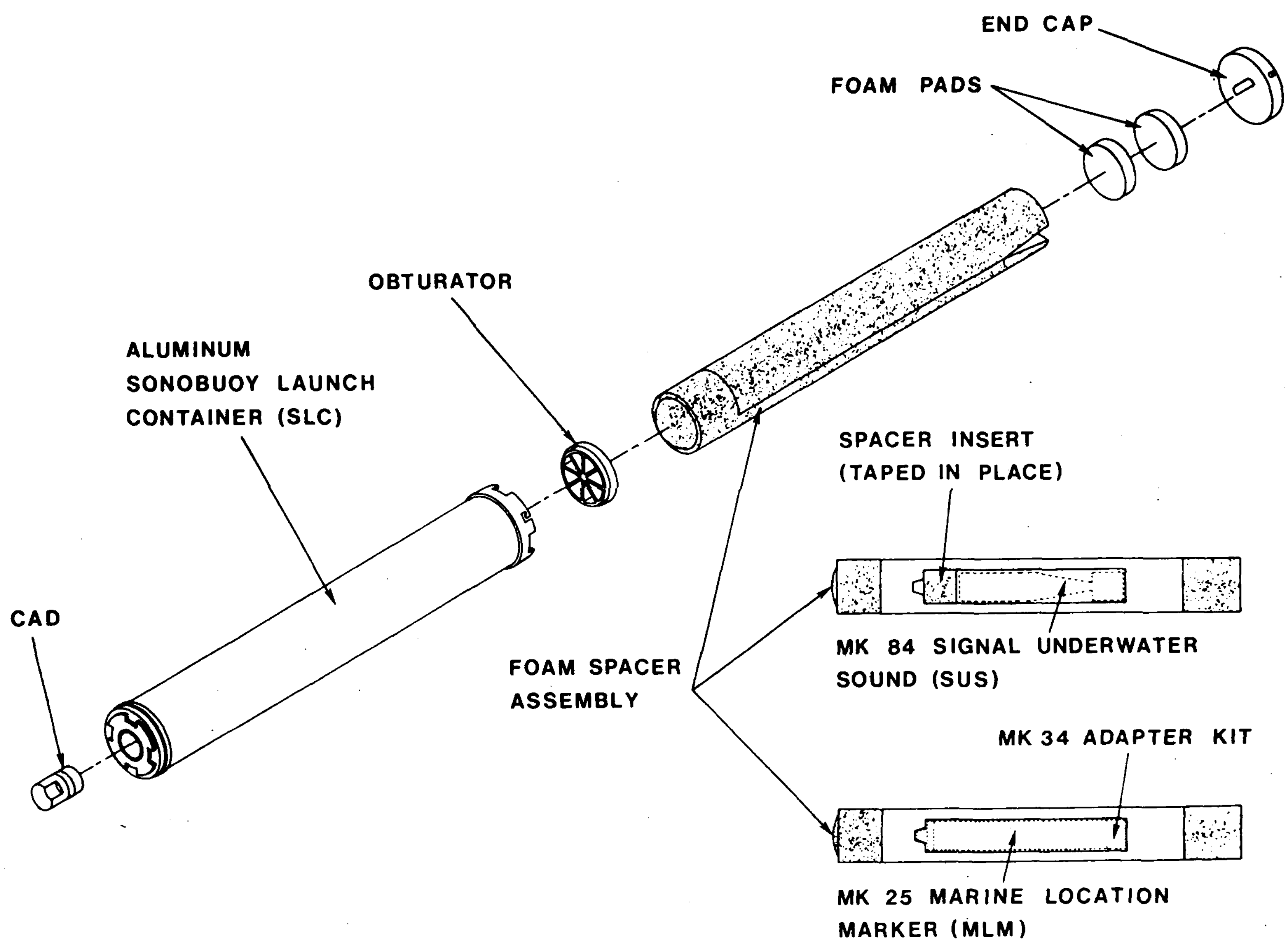
REQ.	ITEM	DESCRIPTION	MAT'L/DWG	DIMENSIONS
4	7	SEAL	SEE NOTE 1	3/4
2	6	STRAPPING	SEE NOTE 1	3/4 X .035 X 15 FT
1	5	TOP PANEL	SEE NOTE 1	1/4 X 39 3/4 X 49 3/4
2	4	END PANEL	SEE NOTE 1	1/4 X 38 1/4 X 39 3/4
2	3	SIDE PANEL	SEE NOTE 1	1/4 X 38 1/4 X 49 3/4
2	2	STRAPPING	SEE NOTES 1 & 2	3/4 X .035 X 17 FT
1	1	PALLET, MK 3	564200	40 X 48

LIST OF MATERIALS

REVIEW ACTIVITIES:
NAVY - OS, AS

PREPARING ACTIVITY:
NAVY - OS
(PROJECT NO. 8140 - N490)

PAGE 2



LOADING ALUMINUM SONOBUOY LAUNCH CONTAINER WITH MLM OR SUS

Of the 150 spacers received at NAVWPNSUPPCEN Crane, a selected sample was checked dimensionally and found to be out of specification. Although a number of other discrepancies were noted, those of particular concern were that: the 36.00 ± .06 inch length dimension on Spacer Half A, Dwg 1019AS1000, was short by .25 inch; the cavity of Spacer Half A did not match up with the cavity of Spacer Half B, Dwg 1019AS1001; and the density ranged from near 4.00 pounds per cubic foot (PCF) to over 6.00 PCF instead of 6.00 ± .50 PCF.

Nine samples 4-11/16 inch diameter and one inch thick were also subjected to a compression test as specified on Dwgs 1019AS1000 and 1019AS1001. All the samples met the minimum compressive strength specified even though the densities on three were well below the 6.00 ± .50 PCF range of the drawings. The results of this test are compared with an earlier test on the original spacer in Table V. This data indicates that the new or modified spacer will be approximately 50% stronger than the original spacer if it is molded to the specified density of 6.00 ± .50 PCF.

Twenty-nine samples were selected and used for static ejection tests by Code 5045, NAVWPNSUPPCEN Crane. The results of the tests shown in Table VI reveal that the modified spacer can be ejected satisfactorily, even if it is .25 inch shorter than specified. A number of the spacers were cracked or broken after the test, but this was mainly due to the fact that they were being fired into a box full of cushioning only six feet from the end of the launcher. It is the writer's opinion that separation of the spacer from the store (marker or signal) is not accomplished as rapidly with the new design making it more susceptible to damage during static, as well as actual ejection tests discussed later. This is in no way detrimental to the function of the spacer, and it may even be beneficial to the environment since the degradation of the spacer is a surface phenomena and there is more surface area exposed on a broken part than on one that remains intact.

Eighty samples were palletized on a metal 40 x 48 pallet and shipped to the Naval Weapons Handling Center at the Naval Weapons Station Earle, New Jersey, for unit load tests. The fleet issue unit load for this item is detailed on MIL-STD-1323/219.

TABLE V
Compressive Strength Tests

Crosshead speed .05 in/min   Maximum stress at 25% deflection
Area of original spacer - 1 square inch (1" x 1" x 1")
Area of modified spacer - 17.26 square inches (4.69" dia x 1")

Sample #	Type Spacer	Density (PCF)	Compressive Strength (PSI)
1	Original	5.00	94
2	Original	5.00	100
3	Original	5.00	105
4	Original	5.00	98
5	Modified	6.15	162
6	Modified	6.18	166
7	Modified	6.16	178
8	Modified	6.00	166
9	Modified	5.87	165
10	Modified	5.85	158
11	Modified	4.18	88
12	Modified	4.20	95
13	Modified	4.11	94

TABLE VI

Spacer: P/N 1019AS1003 PP 6-80
Contract N00104-80-C-A024
NSN 5845-01-098-9532
CAD: JAU-1/B Lot N001 ERI 0179
KMU 410/BKit: Contract N00383-78-C-2409
Also used obsolete design end caps with new obturator.

Sample No.	Length (inches)	Density (PCF)	Store Ejected	Conditioning	Force (lbs)	Avg Vel (ft/sec)	Kit End Cap	*Alignment	See Notes
1	35.69	5.61	Mk 25	Ambient	600	40	New	Optional	1,4
2	35.69	5.22	Mk 25	Ambient	800	42	New	Optional	1,4
3	35.69	5.49	Mk 25	Ambient	800	42	New	Optional	2,4
4	35.69	5.40	Mk 25	Ambient	720	40	New	Optional	3,4
5	35.63	4.92	Mk 25	Ambient	1100	38	New	Optional	2,4
6	35.69	6.32	Mk 84	Ambient	960	44	New	Optional	1,6
7	35.69	5.93	Mk 84	Ambient	1000	46	New	Optional	2,7
8	35.69	4.75	Mk 84	Ambient	1200	42	New	Optional	1,7
9	35.69	5.87	Mk 84	Ambient	1180	48	New	Optional	1,6
10	35.69	6.08	Mk 84	Ambient	1200	42	New	Optional	1,6
11	35.69	5.78	Mk 25	Ambient	1600	38	Old	In-line	1,4
12	35.69	5.59	Mk 25	Ambient	1040	37	Old	In-line	1,4,8
13	35.69	5.74	Mk 25	Ambient	1500	36	Old	90^{0}	2,4,8
14	35.69	5.76	Mk 25	Ambient	800	39	Old	In-line	2,5,8
15	35.69	5.78	Mk 25	Ambient	1920	36	Old	In-line	2,5,9
16	35.69	5.60	Mk 25	Ambient	2800	35	Old	90^{0}	2,5,9
17	35.69	4.60	Mk 25	Ambient	2800	36	Old	90^{0}	2,5,9
18	35.69	4.62	Mk 25	Ambient	2200	42	Old	In-line	2,5,10
19	35.69	4.86	Mk 25	Ambient	2800	44	Old	45^{0}	2,5,10

TABLE VI (cont'd)

Sample No.	Length (inches)	Density (PCF)	Store Ejected	Conditioning	Force (lbs)	Avg Vel (ft/sec)	Kit End Cap	Alignment	See Notes
20	35.69	4.69	Mk 25	Ambient	1100	35	Old	In-line	1,4,10
21	35.69	4.81	Mk 84	Ambient	2400	44	Old	90^{o}	1,7,10
22	35.69	5.65	Mk 84	Ambient	960	44	Old	In-line	1,7,10
23	35.69	4.63	Mk 84	Ambient	2800	46	Old	90^{o}	2,7,11
24	35.69	4.80	Mk 84	Ambient	2000	44	Old	90^{o}	1,6,11
25	35.63	5.47	Mk 84	Ambient	1600	46	Old	In-line	1,6,11
26	35.69	4.98	Mk 25	+ 160^{o}F	1040	40	New	--	1,5
27	35.69	4.68	Mk 25	- 65^{o}F	1200	40	New	In-line	1,5
28	35.69	5.75	Mk 84	- 65^{o}F	2000	43	Old	90^{o}	1,6,11
29	35.69	5.01	Mk 84	+ 160^{o}F	1360	40	Old	In-line	1,6,11

Notes
1. Cracked
2. No cracks
3. Cracked with loose beads present
4. With adaptor
5. Without adaptor
6. Nose towards breech end
7. Nose towards exit end
8. Used same obturator as No. 10 with old style end cap
9. Used same obturator as No. 3 with old style end cap
10. Used same obturator as No. 5 with old style end cap
11. Used same obturator as No. 26 with old style end cap

*Alignment refers to the orientation of the line formed by the joining of the two spacer parts and the shear pins on the end cap of the retainer kit.

First article tests were also performed on the 100 spacers shipped to NAVAIRTESTCEN Patuxent River. Five spacer assemblies were damaged during shipment from the manufacturer and were considered unfit for testing. The other 95 spacers were loaded with Mk 25 Mod 3 Marine Location Markers and Mk 84 Mod 0 Underwater Sound Signals and inserted into the aluminum launch containers. These containers which were fitted with a JAU-1/B Cartridge Actuated Device (CAD) (Figure 10) were then loaded into the sonobuoy launcher aboard an S-3A Aircraft. The detailed loading configurations utilized are presented in Table VII.

Ejections of the loaded spacer assemblies were conducted over Chesapeake Bay. Ground video and wing camera coverage of each ejection were provided. Some ejections occurred without spacer breakage while others broke after they entered the airstream. All ejections of the spacer assemblies were made in level flight at an altitude of 500 feet. Aircraft speed was varied from 175 to 250 knots as shown in Table VII. Most ejections were made with aircraft speed at 250 knots since this is the maximum prescribed in the S-3A manual. Generally, spacer assemblies were ejected six at a pass at approximately one-second intervals.

In order to minimize the handling hazard resulting from burned out markers, the salt water batteries were removed from all Mk 25 markers used in the test. Warning decals were also attached to each marker.

Ninety-four spacer assemblies were ejected during the flight tests. One unit failed to eject because of a defective CAD. All ejections were considered satisfactory after inspection of the S-3A, its sonobuoy launcher tubes, video tapes, and film coverage.

Approximately half of the ejected spacer assemblies were recovered for examination. Most spacer assemblies were broken; however, there was no damage in the solid upper section of Spacer Half A (Figure 10) which fits against the obturator and CAD. Close examination of the high speed wing camera coverage revealed that the breaking of the spacers occurs after the spacer/marker assembly has been ejected from the launcher container.

TABLE VII

NAVAIRTESTCEN Flight Tests
Spacer: P/N 1019AS1003 PP 6-80
Contract N00104-80-C-A024
NSN 5845-01-098-9532
CAD: JAU-1/B See Notes 10 & 11
KMU 410/B: NSN 5845-01-040-5583

No.	Store Ejected	Alignment*	Altitude (ft)	Speed (knots)	See Notes
1	Mk 25	In-line	500	250	1,8,10
2	Mk 25	In-line	500	250	1,8,10
3	Mk 25	In-line	500	250	1,9,10
4	Mk 25	In-line	500	250	1,8,11
5	Mk 25	In-line	500	250	1,8,10
6	Mk 25	In-line	500	250	1,8,11
7	Mk 25	In-line	500	250	1,8,11
8	Mk 25	In-line	500	250	1,9,10
9	Mk 25	In-line	500	250	1,8,10
10	Mk 25	In-line	500	250	1,8,11
11	Mk 25	In-line	500	250	1,3,8,10
12	Mk 25	In-line	500	250	1,3,5,8,10
13	Mk 25	In-line	500	250	1,3,8,10
14	Mk 25	In-line	500	250	1,3,8,10
15	Mk 25	In-line	500	250	1,3,8,10
16	Mk 25	In-line	500	250	2,3,4,10
17	Mk 25	In-line	500	250	2,3,8,10
18	Mk 25	In-line	500	250	2,3,8,10
19	Mk 25	In-line	500	250	2,3,8,10
20	Mk 25	In-line	500	250	2,3,9,10
21	Mk 25	90°	500	250	2,8,10
22	Mk 25	90°	500	250	2,8,10
23	Mk 25	90°	500	250	2,5,8,10
24	Mk 25	90°	500	250	2,8,10
25	Mk 25	90°	500	250	2,8,10
26	Mk 84	90°	500	250	6,8,10
27	Mk 84	90°	500	250	6,8,10
28	Mk 84	90°	500	250	6,8,10
29	Mk 84	90°	500	250	6,8,10
30	Mk 84	90°	500	250	6,8,10
31	Mk 84	90°	500	250	6,8,10
32	Mk 84	90°	500	250	6,8,10
33	Mk 84	90°	500	250	6,8,10
34	Mk 84	90°	500	250	6,8,10
35	Mk 84	90°	500	250	6,8,10
36	Mk 84	90°	500	250	6,8,10
37	Mk 84	90°	500	250	6,8,10
38	Mk 84	90°	500	250	6,8,10
39	Mk 84	90°	500	250	6,8,10
40	Mk 84	90°	500	250	6,8,10
41	Mk 84	45°	500	250	6,8,10

TABLE VII (cont'd)

No.	Store Ejected	Alignment*	Altitude (ft)	Speed (knots)	See Notes
42	Mk 84	45°	500	250	6,8,10
43	Mk 84	45°	500	250	6,8,10
44	Mk 84	45°	500	250	6,8,11
45	Mk 84	45°	500	250	6,8,11
46	Mk 84	45°	500	250	6,8,11
47	Mk 84	45°	500	250	6,8,11
48	Mk 84	45°	500	250	6,8,11
49	Mk 84	45°	500	250	6,8,11
50	Mk 84	45°	500	250	6,8,11
51	Mk 84	In-line	500	175	7,9
52	Mk 84	In-line	500	175	7,9
53	Mk 84	In-line	500	175	7,9
54	Mk 84	In-line	500	175	7,8
55	Mk 84	In-line	500	175	7,9
56	Mk 84	In-line	500	175	7,8
57	Mk 84	In-line	500	175	7,8
58	Mk 84	In-line	500	175	7,9
59	Mk 84	In-line	500	175	7,9
60	Mk 84	In-line	500	175	7,9
61	Mk 84	90°	500	200	7,8
62	Mk 84	90°	500	200	7,9
63	Mk 84	90°	500	200	7,8
64	Mk 84	90°	500	200	7,8
65	Mk 84	90°	500	200	7,8
66	Mk 84	90°	500	200	7,8
67	Mk 84	90°	500	225	7,3,8
68	Mk 84	90°	500	225	7,3,8
69	Mk 84	90°	500	225	7,8
70	Mk 84	90°	500	225	7,8
71	Mk 84	In-line	500	225	7,8
72	Mk 84	In-line	500	225	7,9
73	Mk 84	In-line	500	250	7,8
74	Mk 25	In-line	500	250	1,8
75	Mk 25	In-line	500	250	1,8
76	Mk 25	In-line	500	250	1,8
77	Mk 25	In-line	500	250	1,8
78	Mk 25	In-line	500	250	1,8
79	Mk 25	In-line	500	250	1,8
80	Mk 25	In-line	500	250	1,8
81	Mk 25	In-line	500	250	1,8
82	Mk 25	In-line	500	250	1,9
83	Mk 25	In-line	500	250	1,8
84	Mk 25	In-line	500	250	1,8
85	Mk 25	In-line	500	250	1,8
86	Mk 25	In-line	500	250	1,8
87	Mk 25	In-line	500	200	1,8

TABLE VII (cont'd)

No.	Store Ejected	Alignment*	Altitude (ft)	Speed (knots)	See Notes
88	Mk 25	In-line	500	200	1,9
89	Mk 25	In-line	500	200	1,9
90	Mk 25	In-line	500	200	1,9
91	Mk 25	45^{o}	500	200	1,9
92	Mk 25	45^{o}	500	200	1,8
93	Mk 25	45^{o}	500	175	1,9
94	Mk 25	45^{o}	500	175	1,9
95	Mk 25	45^{o}	500	175	1,9

Notes
1. With Mk 34 Adaptor Kit
2. Without Mk 34 Adaptor Kit
3. With 5/16" extension to increase overall length to 36.00"
4. Defective CAD
5. Spacer cracked prior to flight test
6. Nose towards breech end
7. Nose towards exit end
8. Spacer cracked after ejection
9. Spacer was not damaged
10. CAD Lot 13-REX-0677
11. CAD Lot 05-ERI-0679

*Alignment refers to the orientation of the line formed by the joining of the two spacer parts and the shear pins on the end cap of the retainer kit.

In addition to the flight tests, verification of the proposed Aviation Armament Bulletin (AAB) for use of the improved spacer assembly was performed by personnel of VX-1 stationed at the Naval Air Test Center. VX-1 personnel indicated that they considered the proposed AAC to be adequate and accurate and that the new design was an improvement over the previous one. The bulletin was finalized and distributed as Aviation Armament Bulletin 563 during the week of 15 September 1980.

Since there were a number of discrepancies noted in the first article, a visit was made to the manufacturer to discuss the correction of these deficiencies. In the event that the discrepancies could not be corrected, the manufacturer was advised to request a waiver through the proper channels. The manufacturer agreed to submit an additional sample of 24 to demonstrate that the deficiencies had been corrected.

A second submission of 24 spacer assemblies was received from the manufacturer and dimensional measurements were made on thirteen samples. The following discrepancies were still evident in these samples:

(a) Drawing 1019AS1001 - Spacer Half B dimension 18.000 ± .031 measured 18.070 to 18.085.

(b) Drawing 1019AS1000 - Spacer Half A dimension 18.000 ± .031 measured 18.055 to 18.080; dimension 36.00 ± .06 measured 35.915 to 35.955.

The density of the parts were as follows:

(a) Drawing 1019AS1001 - Spacer Half B density required 6.0 ± .5 PCF, measured 7.19 to 7.65.

(b) Drawing 1019AS1000 - Spacer Half A density required 6.0 ± .5 PCF, measured 6.69 to 7.00.

(c) Drawing 1019AS1002 - Spacer Insert density required 6.0 ± .5 PCF, measured 5.71 to 6.74.

Due to the urgent need for these spacers, the contractor was allowed to proceed after requesting the following waivers:

(a) Drawing 1019AS1000 and drawing 1019AS1001 - Change 18,000 ± .031 to read 18,000 + .093 - .031. Change density from 6.0 ± .5 PCF to 6.0 + 2.0 - .5 PCF.

(b) Drawing 1019AS1000 - Change 36.00 ± .06 to 36.00 + .06 - .09.

(c) Drawing 1019AS1002 - Change density from 6.0 ± .5 to 6.0 + 2.0 - .5 PCF.

Static ejection tests were also performed on samples of the second set of spacers. All ejection tests were considered satisfactory. The configuration and number of units tested are detailed in Table VIII. Based on the results of this test and previous static and flight tests, the spacer was released for production.

TABLE VIII

Static Ejection Tests
on Second Set of Spacer Assemblies

Spacer: P/N 1019AS1003 PP 7-80
Contract N00104-80-C-A024
NSN 5845-01-098-9532
CAD: JAU-1/B Lot 01-ERI-0179
KMU-410/B New obturator with earlier revision end cap

No.	Alignment*	Force (lbs)	Avg Velocity (ft/sec)	Ejected Store	See Notes
1	90^{o}	>2800	71.4	Mk 25	1,5
2	In-line	>2800	75.0	Mk 25	2,5
3	90^{o}	>2800	62.5	Mk 84	4,5
4	90^{o}	2600	136.4	Mk 84	3,6
5	90^{o}	>2800	75.0	Mk 84	4,7

Notes
1. With Mk 34 Adaptor
2. Without Mk 34 Adaptor
3. Nose towards breech end
4. Nose towards exit end
5. Spacer cracked one or two places
6. Spacer remained undamaged
7. Spacer broke into many pieces

*Alignment refers to the orientation of the line formed by the joining of the two spacer parts and the shear pins on the end cap of the retainer kit.

Container Evaluation. Since the packaged item itself is also the major portion of the container, only limited testing was performed on the packaged spacer assemblies. The requirements of MIL-STD-648 specify a drop height of 30 inches for an item of this size but 48-inch drops were performed on the units to insure that they would more than withstand normal handling. The containers successfully passed free-fall drop tests on four corners and two faces from a height of 48 inches with only minor cracks on one end. These cracks in no way impaired the function of the container and the assembly retained its integrity.

III. SUMMARY

The spacer assembly which is made entirely of polystyrene foam is 36.5 inches long, 4.75 inches in diameter, and weights approximately 1.73 pounds. It consists of two nonsymmetrical split sections with a cavity inside to accept a Mk 25 Marine Location Marker equipped with a Mk 34 Adapter or a Mk 84 Underwater Sound Signal. A spacer insert 2.88 inches in length and 3.00 inches in diameter is provided and is to be utilized to fill part of the cavity when the Mk 84 Signal is utilized. The loaded spacer assembly is inserted into the sonobuoy launcher. The purpose of the spacer assembly is to provide a means of launching Mk 25 Marine Location Markers and Mk 84 Underwater Sound Signals from sonobuoy launchers aboard S-3A and P-3C Aircraft.

Four spacer assemblies are postitioned in polystyrene foam end caps and secured with glass filament tape during shipment and storage. Twenty packages for a total of 80 spacer assemblies are palletized on a metal pallet for further consolidation.

The spacer assembly, container and unit load were subjected to various tests to demonstrate compatibility and acceptability and were released for production. A contract was awarded for the initial production of the spacer assemblies to Preferred Plastics Inc., Putnam, Connecticut.

DISTRIBUTION LIST for Spacer Report

	COPIES
Commander Naval Air Systems Command Washington, DC 20361 ATTN: AIR-54112B	2
AIR-53443C	1
AIR-4104C	2
Commander Naval Sea Systems Command Washington, DC 20362 ATTN: SEA-06G3	1
Commanding Officer Naval Avionics Center 6201 East 21st St. Indianapolis, IN 46218 ATTN: Code 942	2
Commanding Officer Naval Weapons Evaluation Facility Kirtland Air Force Base Albuquerque, NM 87117 ATTN: Code 83A	1
Commanding Officer Naval Air Station Norfolk, VA 23511	1
Commanding Officer Naval Air Station North Island San Diego, CA 92135 ATTN: Code 435	1
Commander Naval Air Development Center Warminster, PA 18974 ATTN: Code 6013	1
Commanding Officer Naval Weapons Station Yorktown, VA 23691 ATTN: Code 504	1

DISTRIBUTION LIST (CONT'D)

	COPIES
Commander Naval Safety Center Naval Air Station Norfolk, VA 23511	1
Commander Naval Air Test Center Patuxent River, MD 20670 ATTN: Code SY90 AIRTEVRON ONE	 1 1
Commander Naval Aviation Logistics Center Naval Air Station Patuxent River, MD 20670	1
Commanding Officer Navy Ships Parts Control Center P. O. Box 2020 Mechanicsburg, PA 17055 ATTN: Code 73213	1
Commanding Officer Naval Weapons Handling Center Naval Weapons Station Earle Colts Neck, NJ 07722 ATTN: Code 8023	2
Commanding Officer Ammunition Research and Development Command Dover, NJ 07801 ATTN: DRDAR-LCU-SP (C. Banta)	1
Administrator Defense Documentation Center (DDC) Building 5, Cameron Station Alexandria, VA 22314	12

DATE
ILMED
- 8